
EXECUTIVE SUMMARY
(Advancing Canadian Agriculture and Agri-Food Program [ACAAF]
Progress Report March 2006)

The color of yellow-fleshed potatoes is imparted by carotenoids. Carotenoids are anti-oxidant compounds that may protect against a variety of chronic diseases and certain cancers. Lutein is a specific carotenoid compound associated with a reduced incidence of age-related macular degeneration and cataract formation. This project involved growing ten yellow-fleshed potato varieties in three Alberta locations, harvesting at three different times and analyzing them for tuber flesh color intensity, total carotenoid content and lutein concentration. Total carotenoid content ranged from 17 to 250 μg per 100 g FW and was positively correlated with tuber flesh color intensity, especially when tubers were harvested at 100 days after planting. Lutein accounted for approximately 25% of the total carotenoid content in many varieties and ranged from 3.2 μg per 100 g FW in one variety (Sinora) check to over 50 μg per 100 g FW in the variety Satina. Lutein concentration was determined most by variety, but varied with time of harvest and between locations. Satina and Victoria had consistently higher concentrations of lutein than most of the varieties studied. An average serving of Satina potatoes would provide approximately 100 μg of dietary lutein. Potato varieties with significant concentrations of lutein may be marketed in the future as functional foods.

**Market Opportunity Assessment
for
Lutein in Potatoes in Alberta**

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November 2006

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A. Disclaimer and Acknowledgements

The information contained within this report contains summaries of several papers, studies, opinions and research sources pertaining to opportunities for lutein in potatoes. The author wishes to thank the following people for their assistance in the preparation of this report:

- Dr. Michele Konschuh, Potato Research Scientist, Alberta Agriculture, Food and Rural Development
- Patricia McAllister, Seed Potato Specialist, Alberta Agriculture, Food and Rural Development
- Shirzad Chunara, Health Claims Research Assistant, Alberta Agriculture, Food and Rural Development
- Darcy Driedger, Program Manager, Alberta Agriculture, Food and Rural Development
- Alfonso Parra, Technical Director, Potato Growers of Alberta

B. Definition or description of new idea/product/concept

Lutein (LOO-teen) is one of over 600 known naturally occurring carotenoids. Found in green leafy vegetables such as spinach and kale, lutein is employed by organisms as an antioxidant and for blue light absorption.

Lutein was found to be present in a concentrated area of the macula, a small area of the retina responsible for central vision. The hypothesis for the natural concentration is that lutein helps protect from oxidative stress and high-energy light. Various research studies have shown that a direct relationship exists between lutein intake and pigmentation in the eye. Several studies also show that an increase in lutein concentration in the macular region of the retina decreases the risk for eye diseases such as Age-related Macular Degeneration (AMD).

Lutein is a natural part of human diet when fruits and vegetables are consumed. For individuals lacking sufficient lutein intake, fortification via vitamin tablets or lutein-fortified foods is available. As recently as 1996, lutein has been incorporated into dietary supplements. While no recommended daily allowance currently exists for lutein as for other nutrients, positive effects have been seen at supplemented levels of 6 mg/day. The only definitive side effect of excess lutein consumption is the same observed for β -carotene overdose, namely bronzing of the skin (carotenodermia). The normal levels of lutein found in a daily vitamin are 0.25mg.

C. Executive Summary

Trends

- The baby boomer demographic will continue to shape the market by adopting healthier eating habits. Add to this the younger busy family shoppers, who have strong concerns and interests as well as higher

household income. Thus, the link between nutrition and health/wellness, although not completely understood by consumers, will continue to influence the market.

- Trends indicate that nutrition continues to be an important factor for the majority of Canadians when making food choices. Since many of the purchase decisions are made while shopping, having readily accessible food and nutrition information at the point of purchase would assist consumers in making choices.
- Potato consumption is declining in Canada, noticeably in the fresh and frozen sectors. However, chips and processed potato sectors are increasing as consumers look for "spontaneous" purchases.

Strengths

- Yellow fleshed potato varieties can be competitively grown in Alberta with high lutein content.
- The target markets – the "baby boomer" generation – are likely to purchase a product with health benefits.

Weaknesses

- Consumers may not be entirely aware of the benefits of lutein.
- Lack of profitability at the farm gate may hinder production and therefore marketing of yellow fleshed varieties. In particular, storage losses and high grade outs hinder profitability in the short and long run.

Opportunities

	Time Frame	Impact	Likelihood	Strategies
Market the benefits of yellow fleshed potato varieties to "baby boomers" who eat more potatoes and are concerned with health issues such as AMD.	1 – 2 years	High		A media campaign that is designed to address "maintaining health", specifically the benefits of lutein and AMD; have more promotional materials available.
Promote the benefits of the yellow fleshed varieties.	1 – 2 years	High		Effective merchandising ideas and point of purchase (POP) displays, promotional plans and customer support.
Determine the level of interest and significant factors in consumers decision to purchase potatoes.	1 – 2 years	High		Commission consumer point of sale (POS) surveys on yellow fleshed potatoes.

				varieties such as attributes, willingness to pay, etc.
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Threats

	Impact	Likelihood	Strategies
Yellow fleshed potatoes must compete with white and red potatoes, pasta and white rice for market share.			Have uniformity in labeling; effective product placement in grocery stores; and product consistency in texture and quality.
Many consumers are not sure what "healthy" really means.			Have effective marketing campaigns targeting the benefits of lutein and potatoes.
Farm gate profitability may hinder supply in the short run.			Address grade outs to increase yields and income at farm gate.

Critical Issues and Risks

1. Industry actions

Labeling, product placement and product consistency are critical to the success of this project. All industry players must work together to achieve these goals.

2. Consumer education

Nutrition is not ranked high on the scale of "first to mind" in purchasing potatoes. An assertive education process highlighting the benefits of yellow fleshed potatoes would need to be undertaken.

3. Farm gate profitability

If yellow fleshed varieties cannot be grown at a profit, growers will not switch to these varieties. Thus, the ability to supply potential market demand will be compromised. As this market is relatively small and there may be only one or two small to medium sized fresh market wholesalers, there may be only a few growers that will enter into yellow fleshed potato production. In other words, the market may sort this problem out.

D. Key Market Drivers

Global Market and Industry Trends

Lutein is classified as a carotenoid and competes with other carotenoids. A 2005 study by BCC, Inc. concluded that lutein has been the big marketing success in recent years. Until the end of the 1990s, lutein was mainly used to color egg yolks and partly for broiler skin. After 2000, a new application developed in

Source: Potato Growers of Alberta

Designation	1998	1999	2000	2001	2002	2003	2004	2005	2006
Processed	12800	24616	32563	34877	37296	40960	38077	38508	36633
Seed	10250	10886	12037	12595	14644	13690	11062	10531	11878
Table	5100	4698	4331	3883	3241	4125	3508	2567	1575
Total	28150	40200	48931	51355	55181	58775	52647	51606	50086

Alberta Potato Acreage
1998 – 2006

Total potato production in Alberta increased rapidly until 2003 and has decreased since that time. While designated seed potato acres have remained relatively constant, table potato acreage continues to drop due to lack of profitability. However, there is room for growth since table potato acreage has averaged over 4,000 acres prior to 2003.

Potato Production

Source: BCC, Inc.

*Includes Lycopene, Annatto, Zeaxanthin, Apo-carotenal and Apo-carotenal-ester.

Product	2004	2009	AAGR% 2004-2009	Percent of Total, 2004	Percent of Total, 2009
Astaxanthin	234.0	257	1.9	26.4	25.1
Beta-carotene	242.0	253	0.9	27.3	24.7
Lutein	139.0	187	6.1	15.7	18.3
Canthaxanthin	148.0	156	1.1	16.7	15.2
Others*	123.9	170	6.5	14.0	16.6
Total	886.9	1,023	2.9	100.0	100.0

Global Carotenoid Market by Product Type, through 2009
(\$ Millions)

supplements when it was demonstrated that lutein could help to reduce age-related macular degeneration disease. A new outlet in supplements was created and pushed lutein's market value up to \$139 million in 2004, compared to \$64 million in 1999. It is anticipated that strong growth will continue, and thus, lutein's market will grow at an average annual growth rate (AAGR) of 6.1% through the forecast period.

**Alberta Potato Acreage
1998 – 2006
Percent of Total Acres**

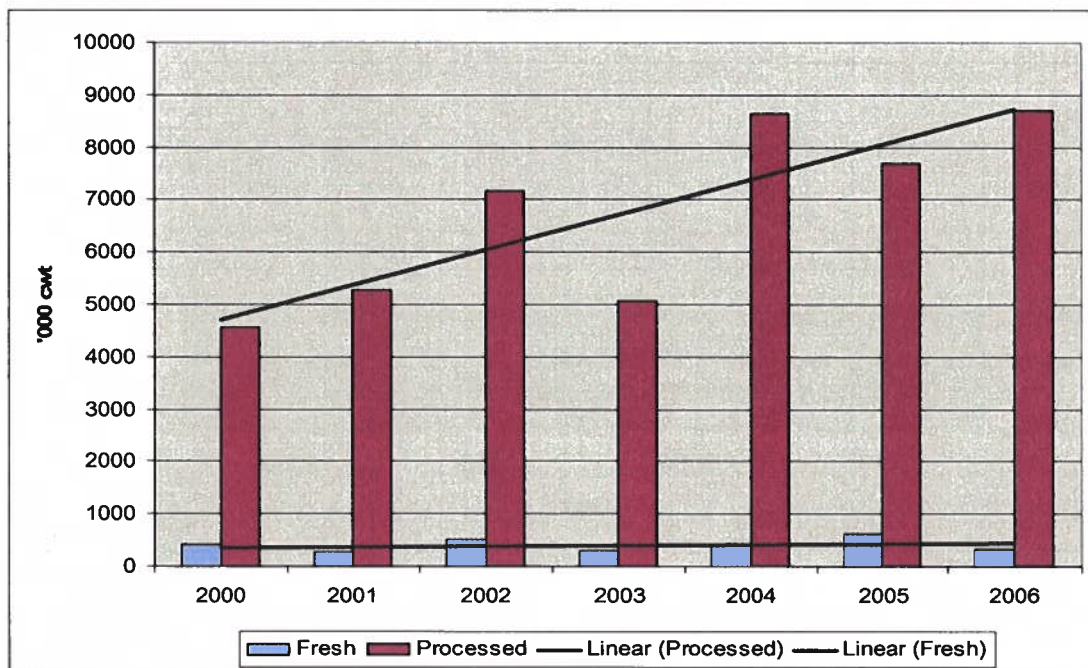
Designation	1998	1999	2000	2001	2002	2003	2004	2005	2006
Processed	45%	61%	67%	68%	68%	70%	72%	75%	73%
Seed	36%	27%	25%	25%	27%	23%	21%	20%	24%
Table	18%	12%	9%	8%	6%	7%	7%	5%	3%

Source: Potato Growers of Alberta

Utilization

Intended uses of both fresh and processed potatoes in Alberta have seen fluctuations over the years. As with the acreage, it is apparent that the trend is toward more processed potatoes, while the fresh potato market has stayed remarkably constant.

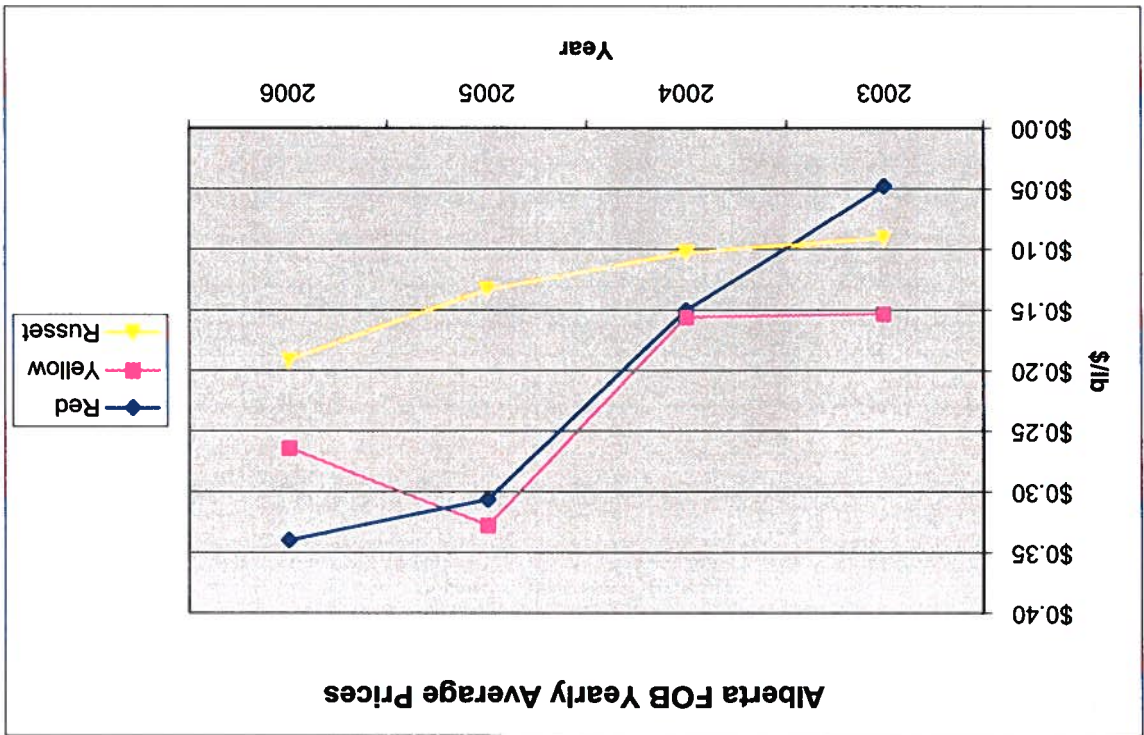
**Intended Utilization of Potatoes, Alberta
Fresh and Processed**



Pricing

The following chart shows the wholesale (packer) FOB potato prices in Alberta. These prices do not reflect the prices received at the farm gate. However, some general observations can be made. Red and yellow varieties, which are exclusively fresh market, have seen substantial price increases since 2003. This can be attributed to a number of factors:

- An increase in demand as these varieties are seen as a "healthier" alternative by consumers. Russet potatoes have shown price increases to a lesser extent.
- Production restrictions in the United States through the United Fresh Produce Association.
- Competition from other parts of North America that produce the Russet Burbank variety for the processing market.
- A decrease in the volume of fresh market russet potatoes. The Russet Norkotah is grown exclusively for table production but are less palatable than many other varieties when consumed as a baked potato, especially after being held in cold storage for long periods. Along with the current low-carb diet fad, Russet Norkotah's out-of-storage quality issues may be contributing to the slow decline in overall fresh potato consumption.



Source: InfoHort, Agriculture and Agri-Food Canada

E. Consumer Analysis and Opportunities

What Do Consumers Really Want?

Consumers choose foods at the grocery store for a variety of reasons. Many studies indicate that the top five most important factors that consumers consider when buying food products are as follows, in order of significance:

1. Freshness/Quality
2. Price
3. Nutrition
4. Taste

5. Brand

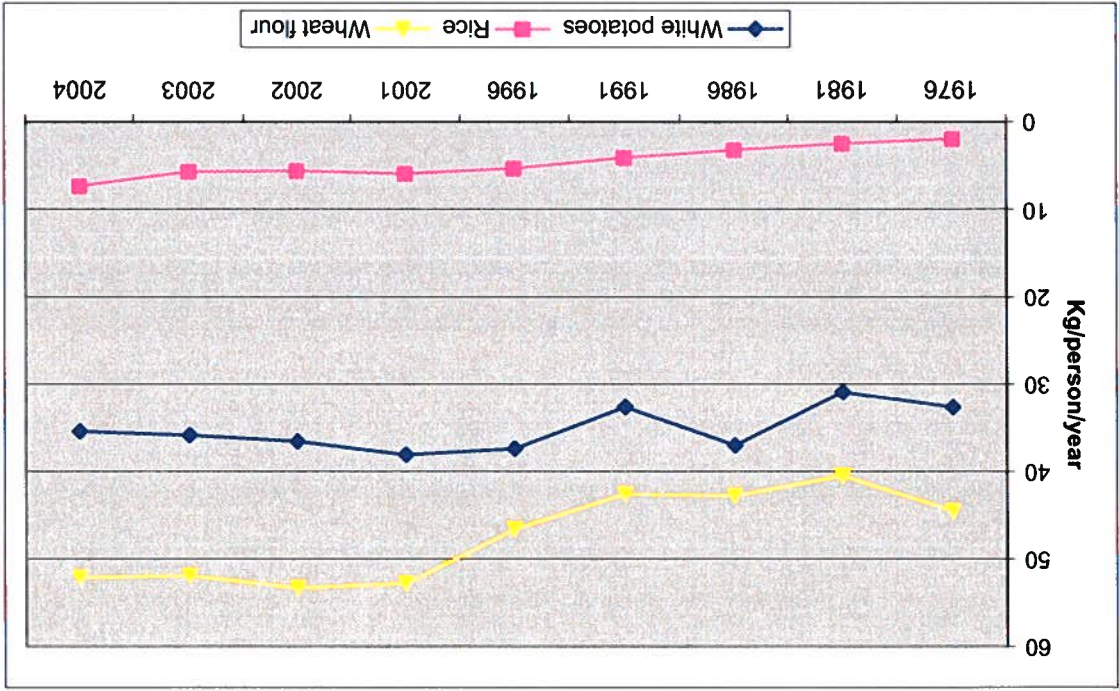
Other factors include sale/promotion/coupons, convenience, food safety and functional properties.

The baby boomer demographic will continue to shape the market by adopting healthier eating habits. Add to this the younger busy family shoppers, who have strong concerns and interests as well as higher household income. Thus, **the link between nutrition and health/wellness, although not completely understood by consumers, will continue to influence the market.**

Trends indicate that nutrition continues to be an important factor for the majority of Canadians when making food choices. Since many of the purchase decisions are made while shopping, having readily accessible food and nutrition information at the point of purchase would assist consumers in making choices.

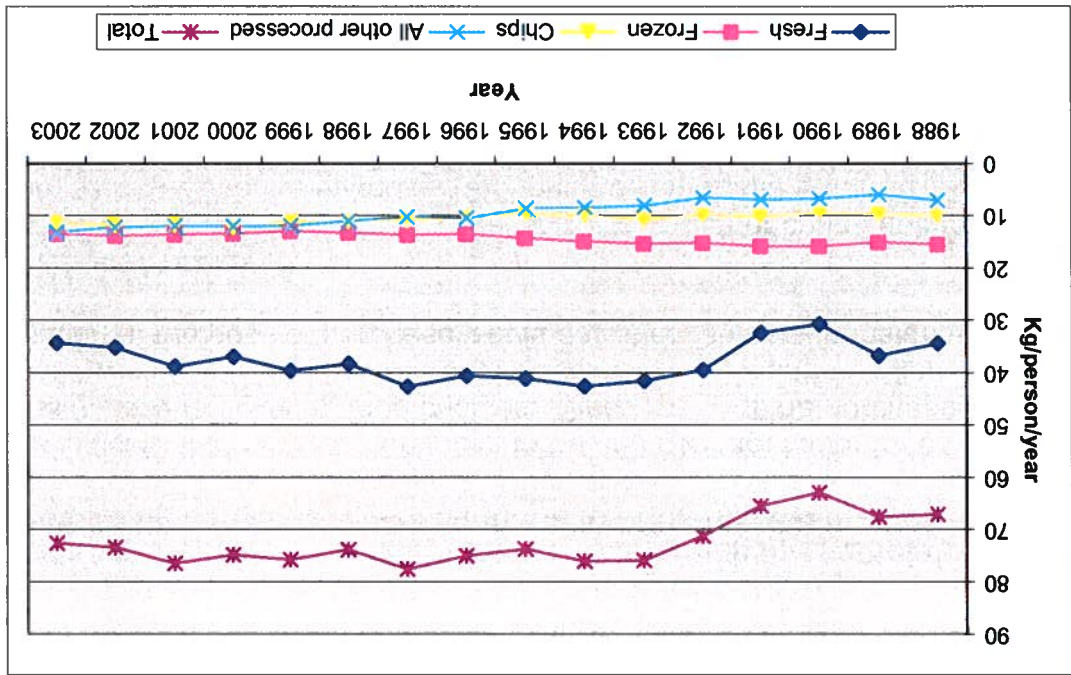
What About Potatoes?

According to a paper completed by Statistics Canada, per capita potato consumption in Canada peaked in 1997 and has stabilized around 74 kg per person since that time. Specifically, consumption of fresh potatoes has been showing a gradual decline, as has consumption of frozen potato products. However, consumption of other processed potato products, such as pressed potato chips and dehydrated product, is increasing.



Food Consumed, By Commodity
Potatoes and Substitutes

In addition, potatoes have lost market share to its direct starch substitutes – rice and pasta – since 2001.



Canadian Per Capita Consumption of Potatoes and Potato Products
In Fresh Equivalent or Farm Weight
Per Annum

This can be attributed to a number of factors:

- Increased consumer demand for greater varieties and more convenience in all products;
- Little consumer recognition of potato varieties and uses;
- More health conscious consumers concerned about the carbohydrates in potatoes;
- Potatoes are a “planned purchase” to go with a prepared meal (typically one of the four protein groups). Consumers who buy “spontaneously” will not purchase potatoes.

A recent study completed by Compas Inc. for the Ontario Potato Board of 1002 Canadians identified some key findings in potato consumption.

1. Canadians under age 55 years are less likely to eat potatoes often than are those over age 55
 - Respondents over age 55 consumed potatoes 2.4 times in the three days preceding the survey.
 - Canadians under 55 years of age consumed potatoes 1.8 times a week. This group also tends to consume pasta and rice more frequently than do older Canadians.
2. Taste versus nutrition
 - Most respondents (42%) said they eat potatoes more often than other foods because of the taste.
 - Only 10% of respondents said they eat potatoes more often than other foods for health reasons.
3. Timing
 - 75% of respondents said they eat potatoes at least two to three times a week.
 - Only 3% reported eating potatoes once or twice a year.
4. In what form do Canadians like to eat their potatoes?
 - Boiled (28%), mashed (25%), baked (25%), fried (11%) and potato chips (5%)
5. The regions where Canadians consume potatoes at least two to three times per week:
 - Atlantic Canada – 87%
 - Quebec – 78%
 - Western Canada – 74%
 - Ontario – 70%

Factors Influencing Purchase of Potatoes

Given the factors above, what does this mean for the future potential of marketing yellow fleshed potatoes for lutein qualities?

1. Demand

Unfortunately, overall fresh potato consumption is falling as younger families with higher household income purchase less fresh potatoes. Two main drivers are

Yellow potatoes	74,781	1,394,448
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Median values of consumption

White potatoes	\$ 11,346,340
Red potatoes	\$ 4,491,260
Yellow potatoes	\$ 680,053

Over the ten year time period, the yellow potato market will average a significant increase in demand of \$680,000. This translates into an increase of \$346,000 over current market size or an average annual growth rate (AAGR) of 7.1%. It is important to note that the growth targets are quite aggressive for the yellow fleshed varieties and it is assumed that they will take market share from red and white varieties.

Given these assumptions, a market of this size could possibly attract one or two smaller wholesalers. These wholesalers would probably be existing companies who have the facilities to add fresh yellow potatoes in their product line. They would also have the facilities to handle yellow potatoes and a direct line to the retailer.

F. Competitive Advantage

Production

In 2004, Dr. Michele Konschuh of Alberta Agriculture, Food and Rural Development undertook a research study of twenty yellow fleshed varieties in the province. This study demonstrated that a number of these varieties can be grown successfully in Alberta with high lutein content.

Specific results:

- Of the twenty different varieties grown in Alberta, total carotenoid concentration in yellow-fleshed potatoes ranged from 35 to 240 mcg/100 g FW.
- In most varieties, lutein made up to 1/3 of the total carotenoid content.
- Zeaxanthin concentration was negligible in the varieties.
- Lutein concentration ranged from 9.5 (check) to over 50 mcg/100 g FW (Satina).
- A number of varieties have processing potential: Innovator, Sante, Satina, Sinora, and Victoria
- Five varieties have potential to market as fresh: Agata, Island Sunshine, Piccolo, RZ94-83 (Cecile), and Satina.
- Lutein concentration is correlated with variety, but can be influenced by growing location, storage and cooking or frying.
- A seven ounce potato may contribute between 20 and 50% of the lutein in a supplemented multivitamin.

Profitability

There are two critical production decision rules for owner/operators of farms. The first is the "rule for the short run": production should continue if projected revenue would at least cover variable costs. That is, gross margin must be positive. The second rule is the "rule for the long run": production should continue if all costs could be covered. In other words, return to management must be positive.

Another useful rule is Net Present Value. Net present value (NPV) is a standard method for evaluating competing long-term projects in capital budgeting. It measures the excess or shortfall of cash flows, in present value (PV) terms, once financing charges are met. All projects with a positive NPV should be undertaken.

Using a ten year simulation technique, we can estimate average gross margin and return to management over the time period as well as the net present value. Prices and yields will be input as distributions. The discount rate for NPV is assumed at 7%, a relatively conservative figure.

Assumptions

	Minimum	Maximum	Most likely
Selling price in year 1 (\$/tonne)	\$60.00	\$130.00	\$110.00
Yield (tonne/acre)	10	19	17
Storage loss (on-farm)	5%	15%	10%
Grade out at packer	15%	30%	20%

The table below indicates that both gross margin, return to management and net present value are negative over the ten year time period using the given assumptions.

Simulation Outputs

	Per Acre
Net Present Value	(\$20,776)
Gross Margin	(\$543)
Return to Management	(\$2,243)

A useful risk analysis tool is the "breakeven analysis". This analysis provides the producer with a yield and price that would be needed so that gross margin or return to management is zero. The following tables show the breakeven price and yields for yellow skinned potatoes with the given production costs.

Health Claims – U.S.
 Carotenoids, specifically lutein and zeaxanthin, have FDA approval pending because of epidemiologic data. A recent decision by the FDA rejected the qualified health claim petition for Xangold® Lutein Esters and age-related macular degeneration and cataract formation. In their decision, the comments were supportive of a qualified health claim regarding lutein and certain eye diseases, but considered the subject of the petitioner's proposed claim too restrictive. Most commented that the available evidence for a relationship between lutein and eye diseases involved the unesterified, "free" form of lutein, not the esterified form. The thirteen comments indicated that the subject of any authorized claim should be lutein and/or lutein-containing foods instead of lutein esters.

G. Legal and Regulatory Issues

Addressing these two major risks is paramount in the success of this project. Growers who have minimal debt on both their major capital items – land, machinery and buildings – are more apt to plant the yellow fleshed varieties. Locating and contracting with these growers will be essential. Reducing or eliminating the grade out percentage would take away the "double hit" that producers experience in selling their product and reducing their income.

- There are two main reasons:
- High production costs, which typically come in between \$2,500 to \$3,000 per acre for irrigated potatoes; and
 - A "double hit" for producers that typically lose 10% from storage losses at the farm gate and a further 20% at the packer for grade out.

Analysis
 Profitability presents a significant barrier to increasing the supply of yellow fleshed potatoes. The high break even prices and yields to cover economic costs (which include land rent, water rates, and interest) are a major concern. With current prices at least \$30/tonne below the break even, the incentive for growers to plant yellow potatoes is negligible both in the short and long term.

Break Even Yield

Tonnes per acre	13.91
Cash costs	29.37
Economic costs	

Break Even Selling Price

Per tonne	\$90.03
Cash costs	\$190.03
Economic costs	

Health Claims - Canada

In Canada, product labels can only make a content claim (i.e.) x mg of lutein per serving. There can be no mention of the “benefits” of lutein such as AMD on the label.

H. Conclusion

Marketing yellow fleshed potato varieties for the fresh market does have potential in Alberta. The size of the market indicates that one or possibly two small to medium size wholesalers can add these varieties to their existing product line. A direct link to the grocer and an aggressive marketing campaign highlighting the health benefits may achieve growth targets. Targeting the “baby boomers” should be a first step as they are the likely demographic to purchase these potatoes.

Grower profitability may be a limiting factor as prices are below cost of production and growers will not switch if there is no evidence of short or long term profitability.

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